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Tsuchida et al.

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[54] **APPARATUS FOR REGENERATING FILTER CLOTHES OF FILTER PRESS**

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[21] Appl. No.: **779,483**

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[30] **Foreign Application Priority Data**

Oct. 1, 1996 [JP] Japan 8-260927

[51] **Int. Cl.**[6] **B01D 25/34**

[52] **U.S. Cl.** **210/225**; 210/230

[58] **Field of Search** 210/225, 227, 210/229, 230; 100/198

[56] **References Cited**

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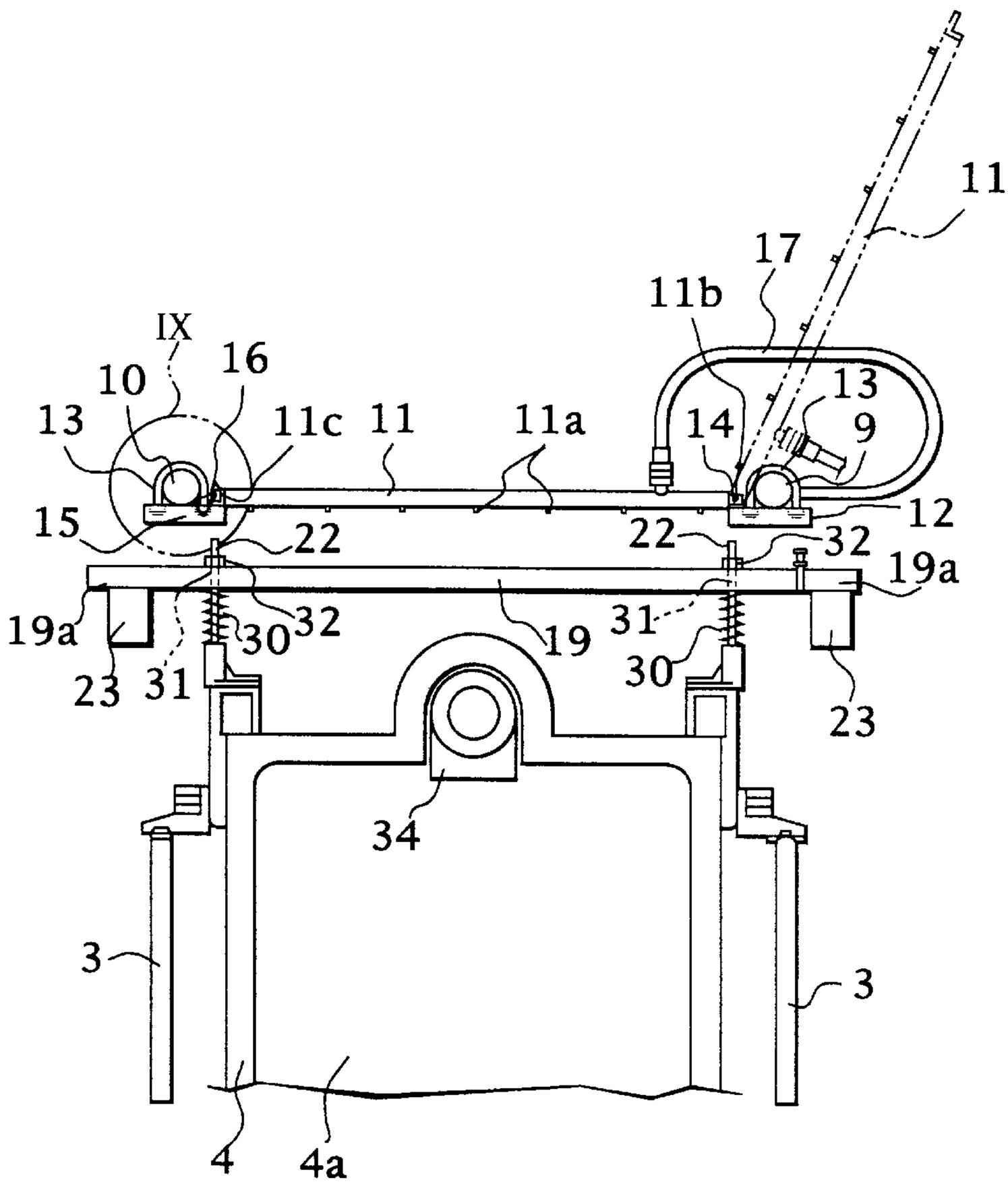
Primary Examiner—Matthew O. Savage

Attorney, Agent, or Firm—McDonnell Boehnen Hulbert & Berghoff

[57] **ABSTRACT**

A vibration rod for simultaneously vibrating upper-portion support bars arranged to be upwards brought into contact with two ends of the upper-portion support bar to simultaneously vibrate the upper-portion support bars is disposed below the bar for supporting the upper portion of each of filter clothes each of which is disposed between filter plates; and washing pipes each having nozzles pointed to the filter cloth from a position above a gap between filter plates are disposed above the filter plates disposed in parallel so that cakes allowed to adhere to the filter clothes are separated by vibrating the filter plates simultaneously with opening of all of the filter plates. Then, washing water sprayed from the nozzles enables all of the filter clothes to simultaneously be washed and regenerated.

6 Claims, 11 Drawing Sheets



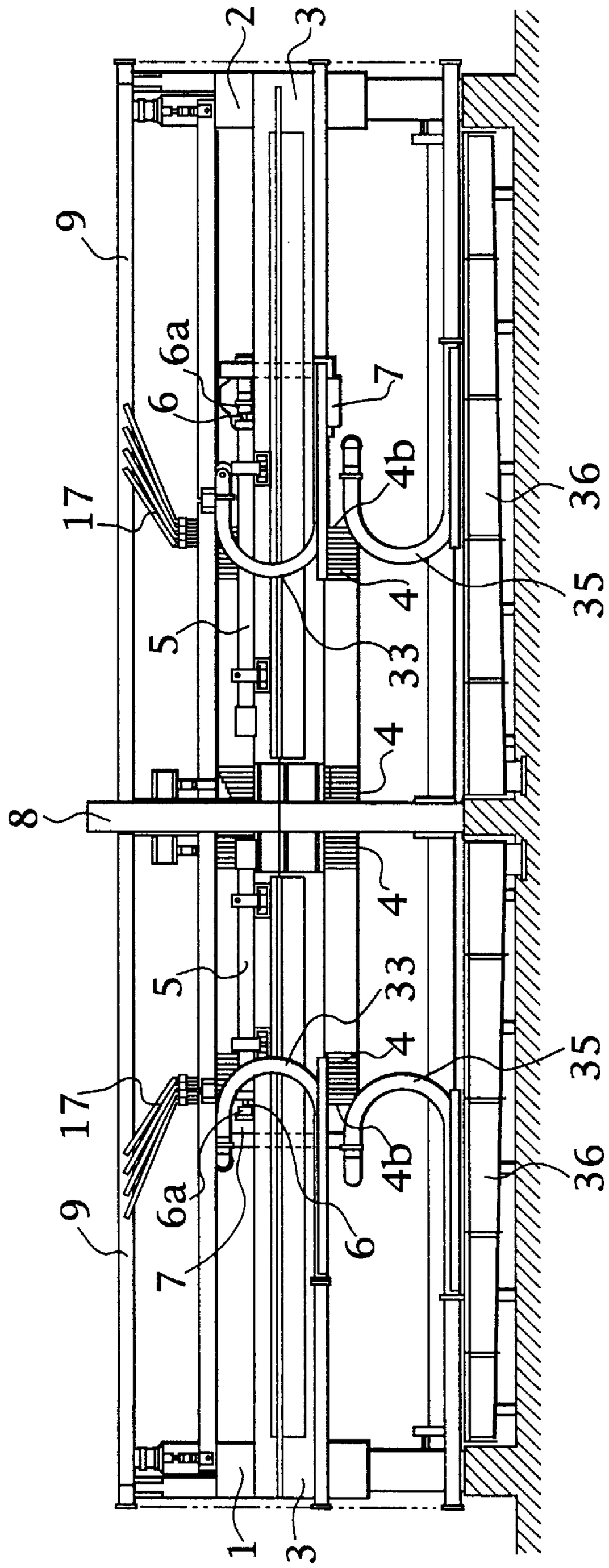
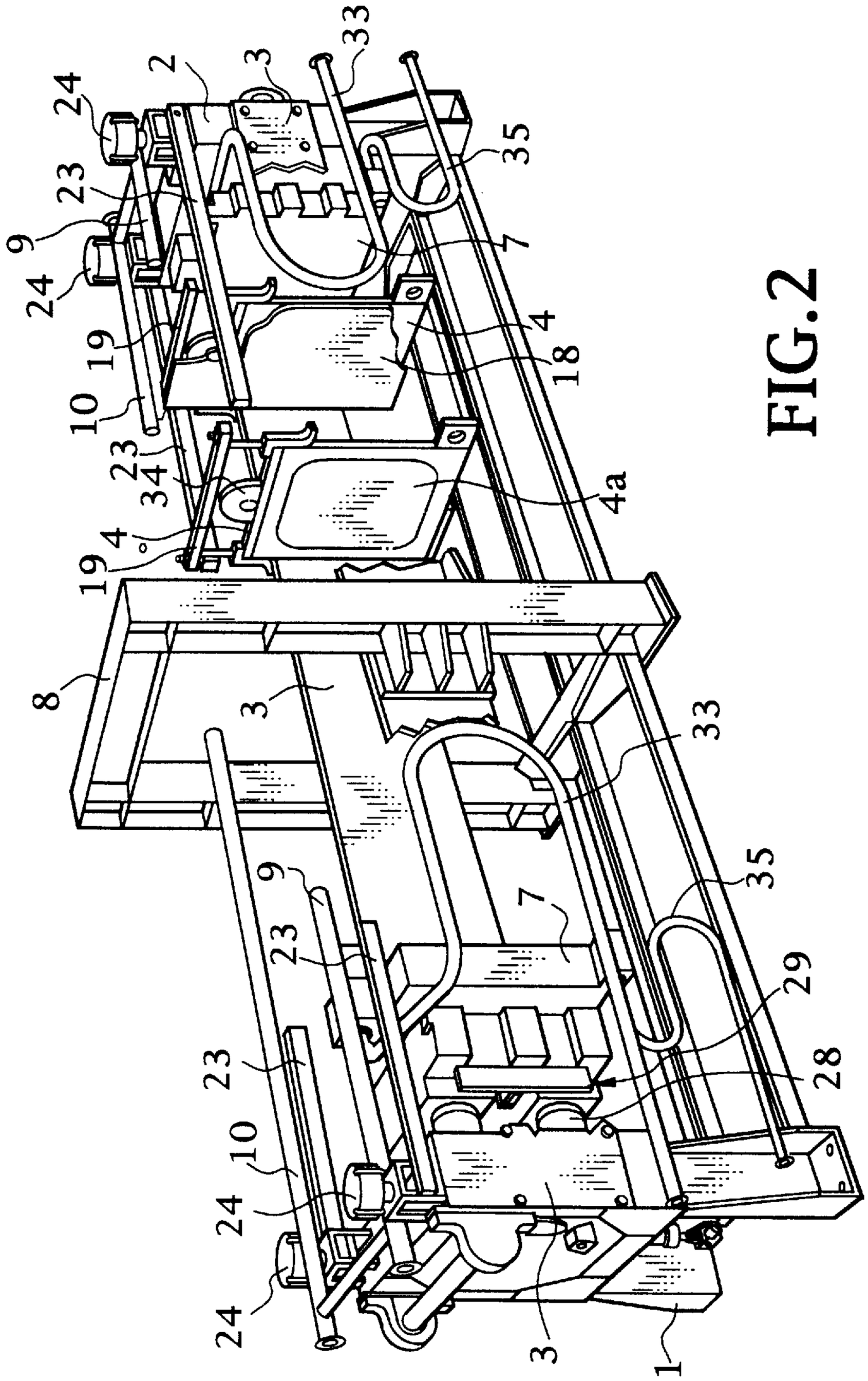


FIG.1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18
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FIG.2

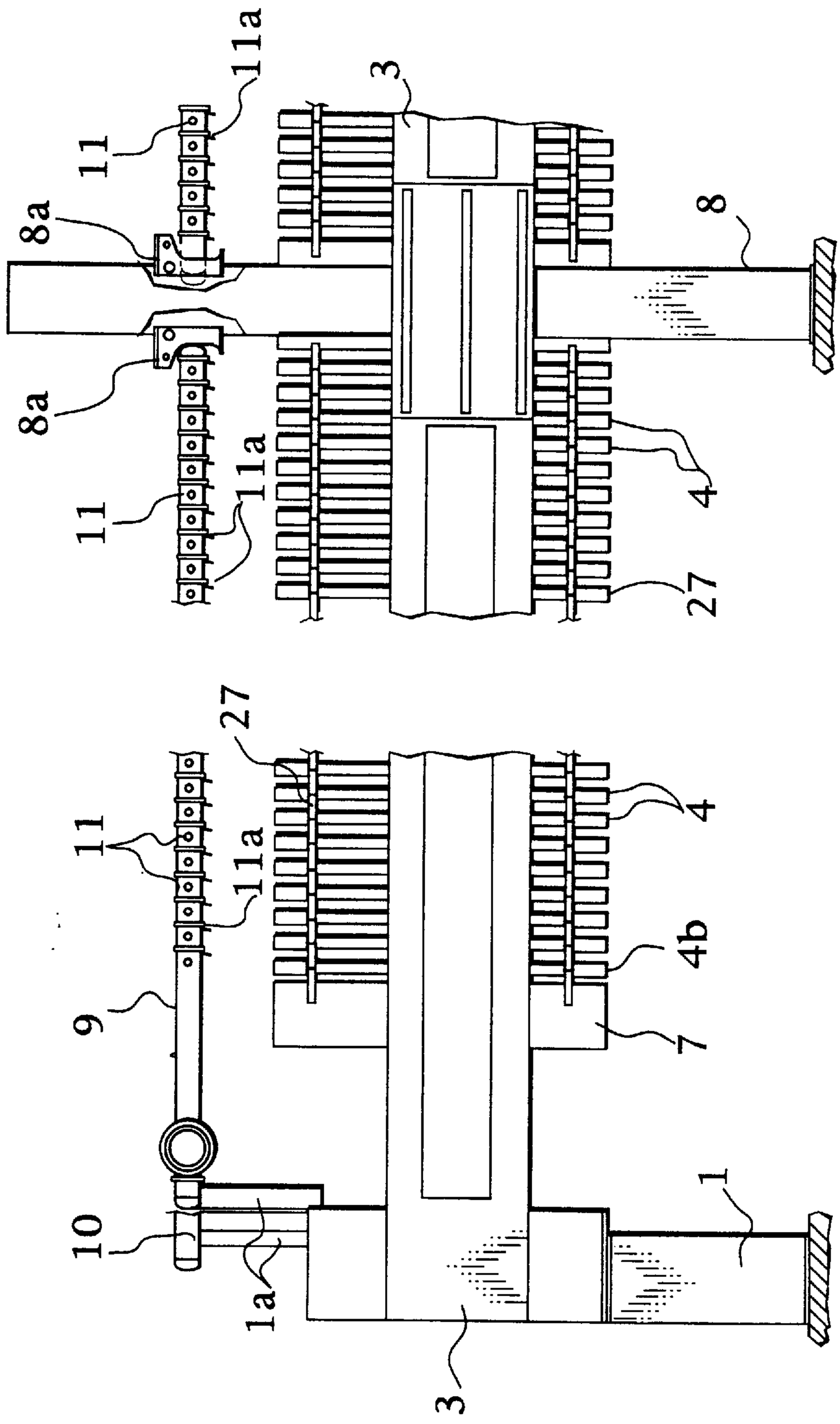
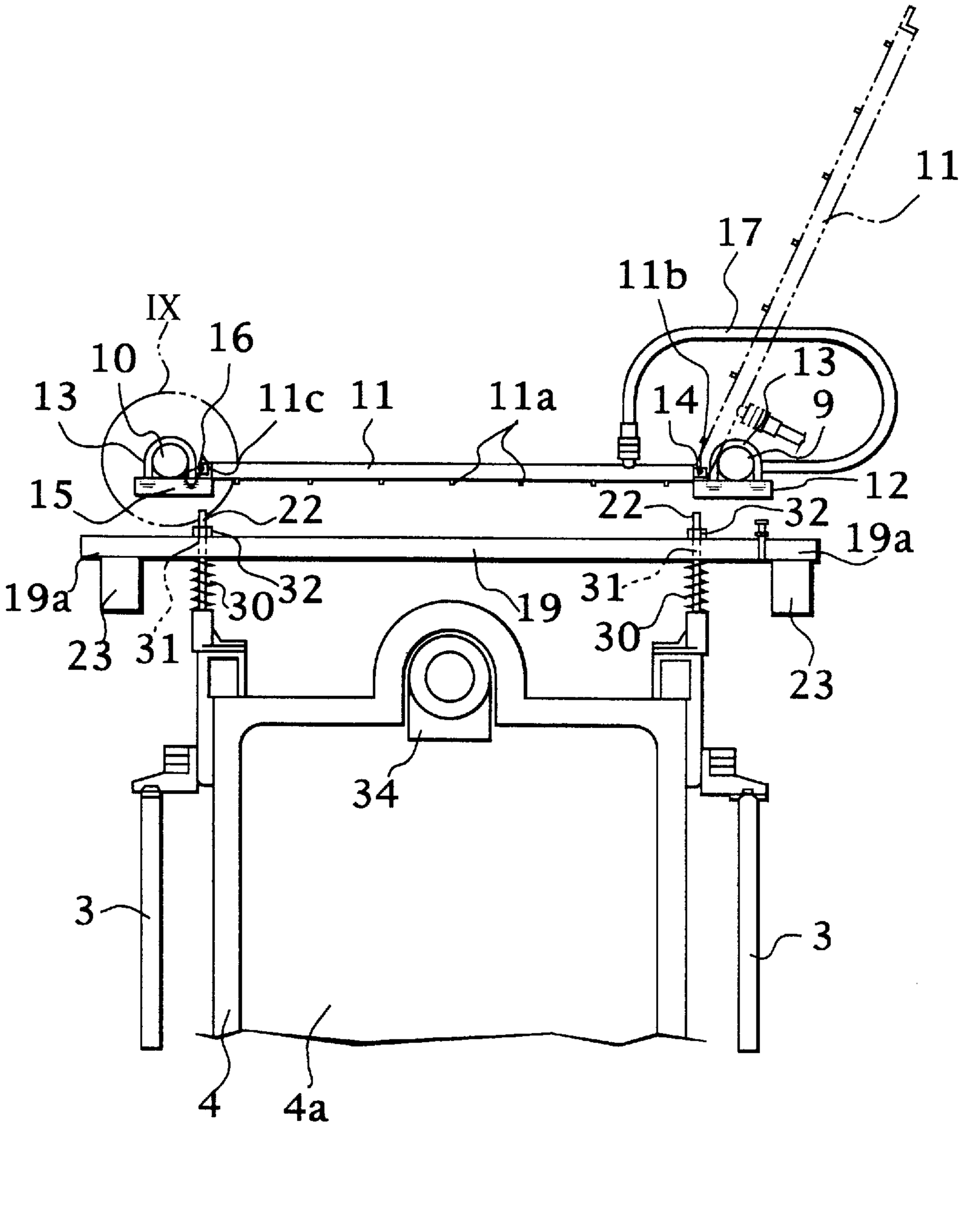


FIG. 3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17
11b
IX
16
10
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11c
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11a
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15
22
22
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34
3
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4
4a

FIG.4

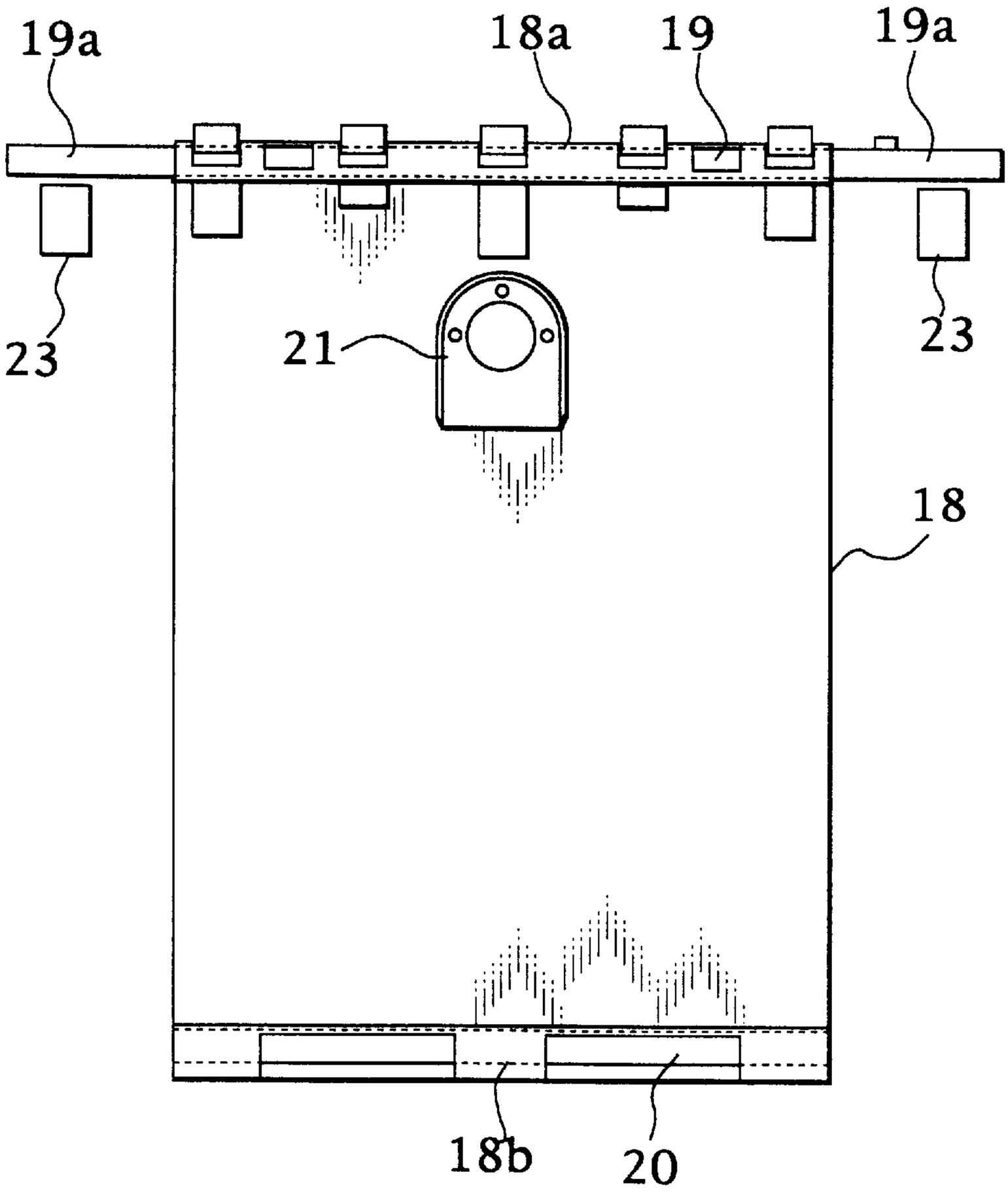

FIG.5

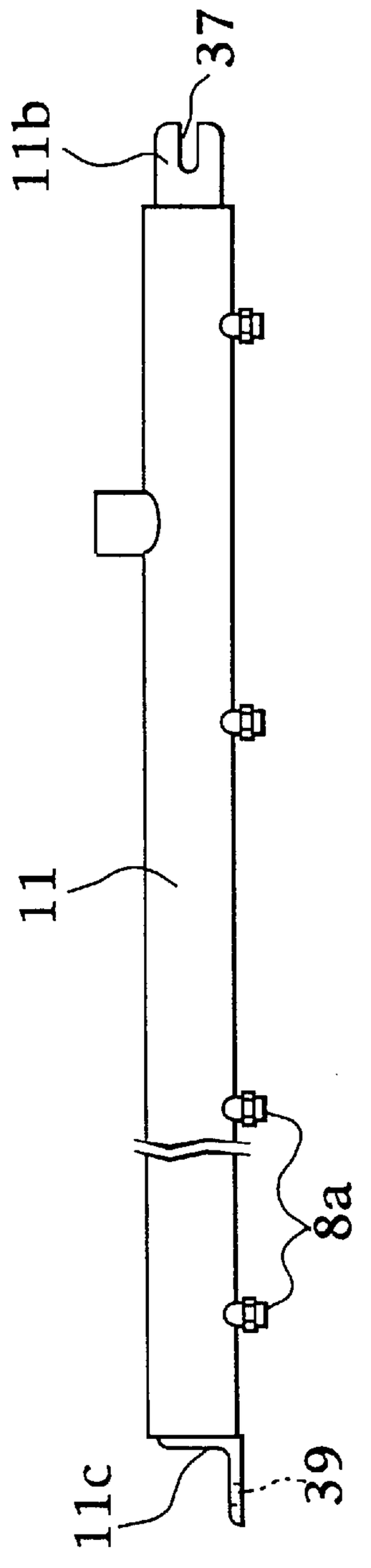

FIG.6

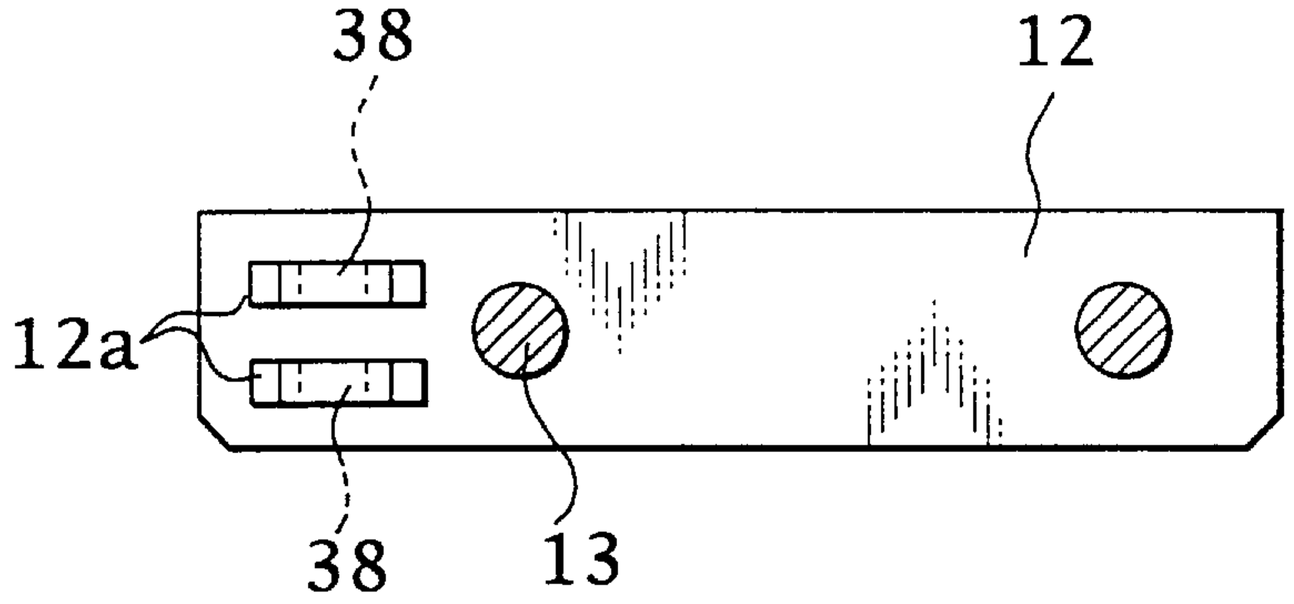

FIG.7

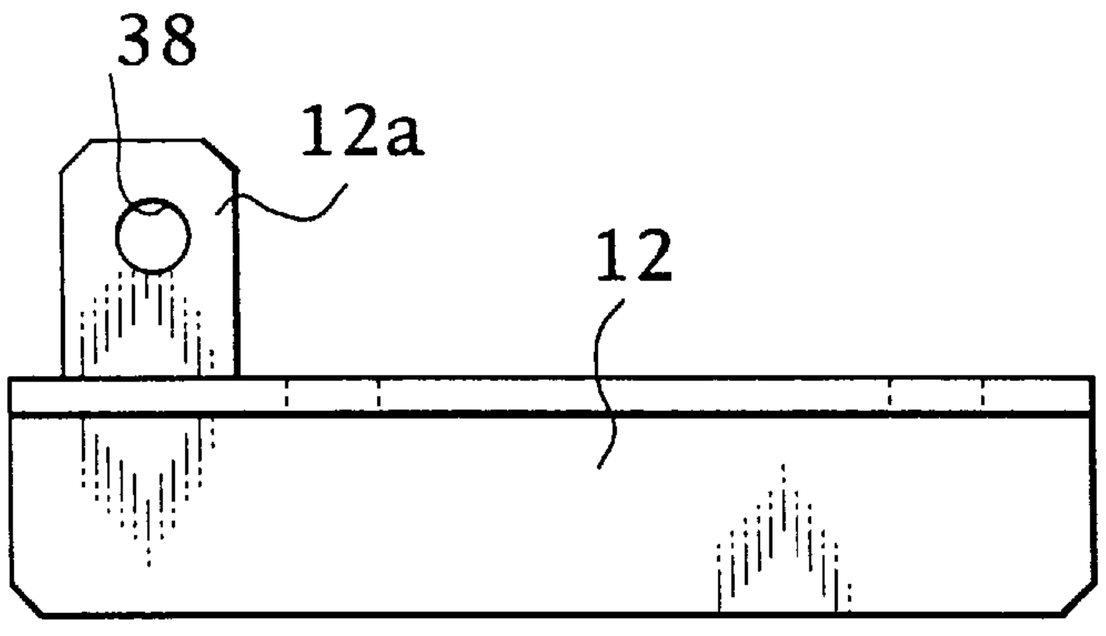

FIG.8

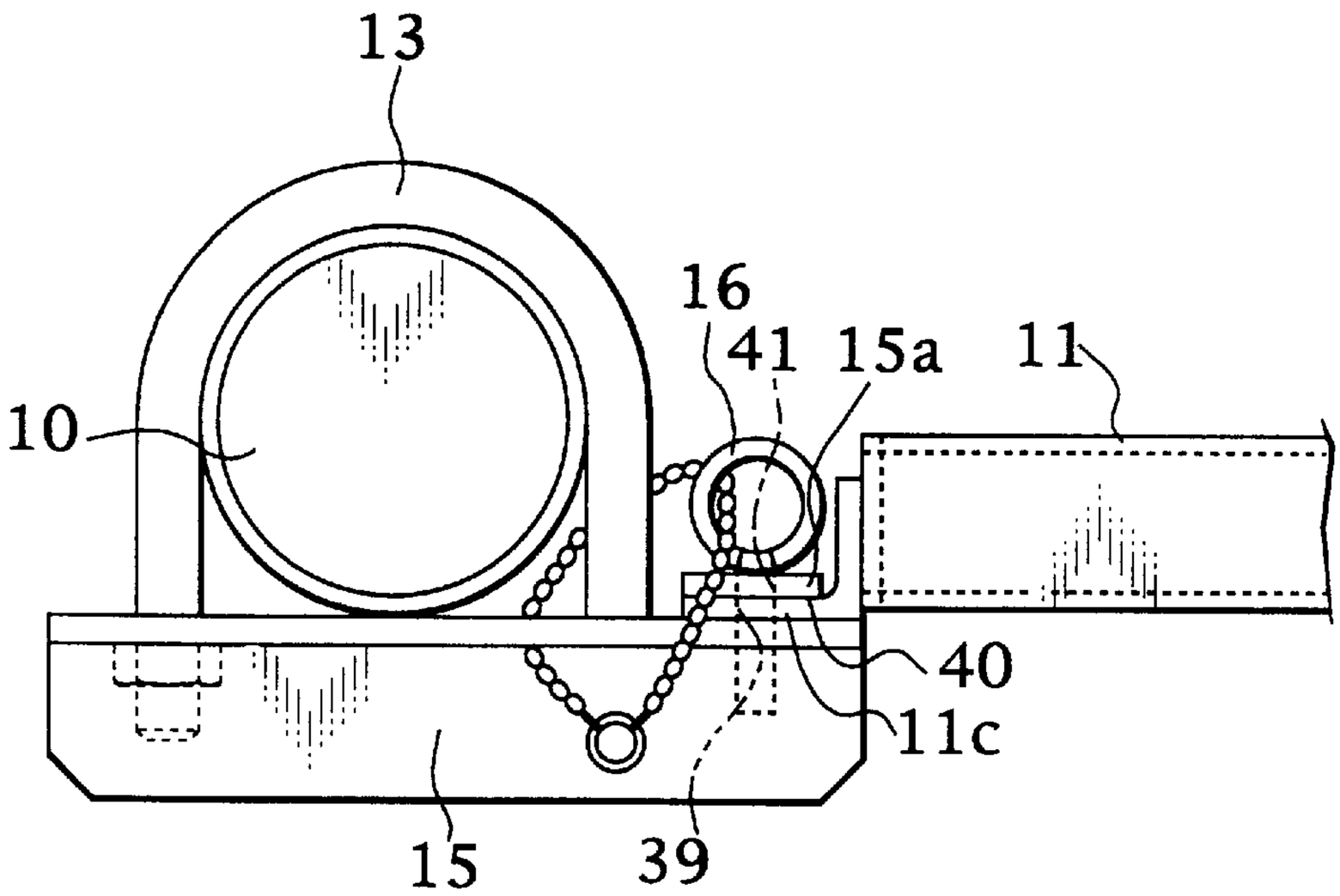

FIG.9

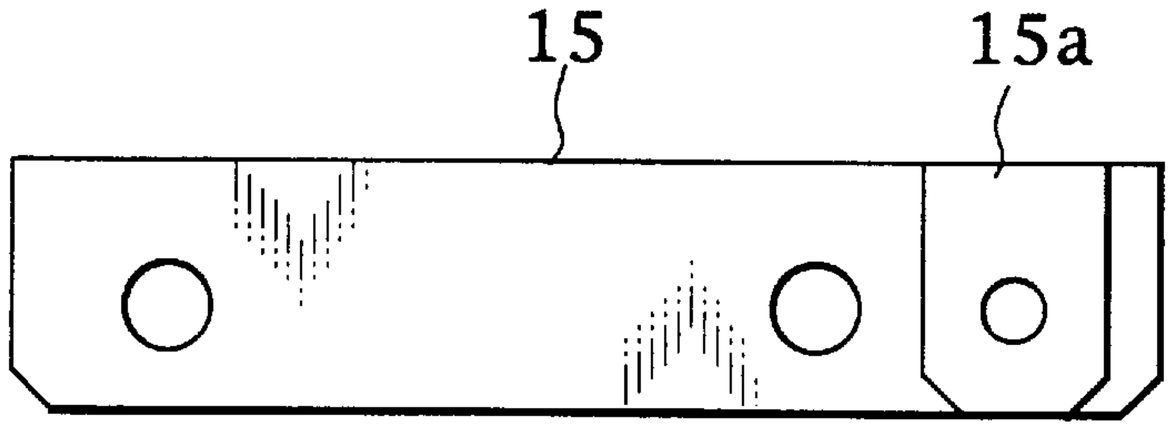

FIG.10

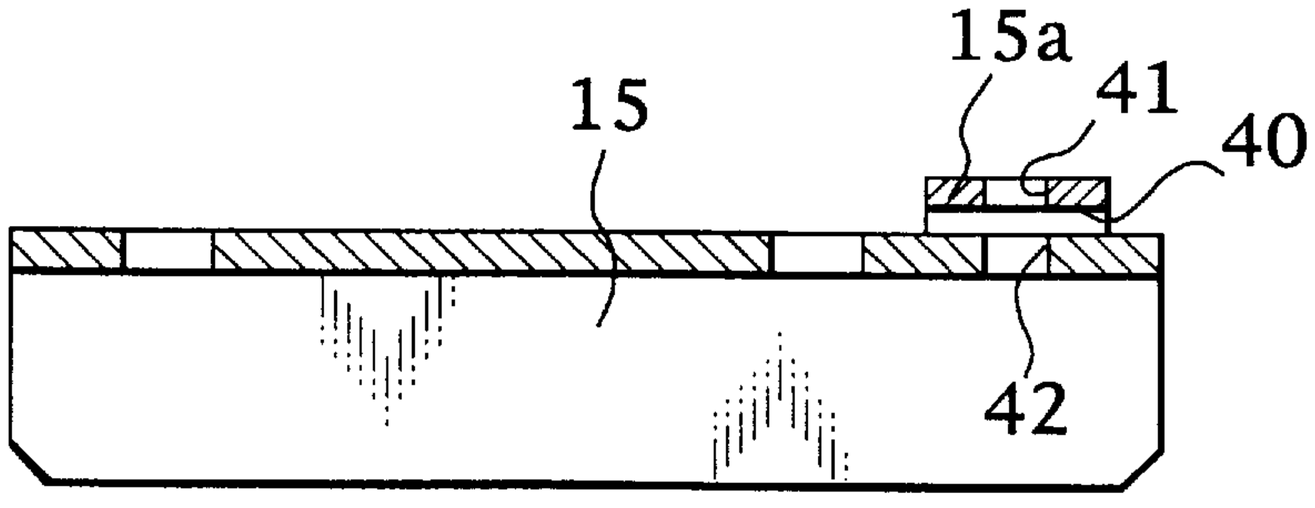

FIG.11

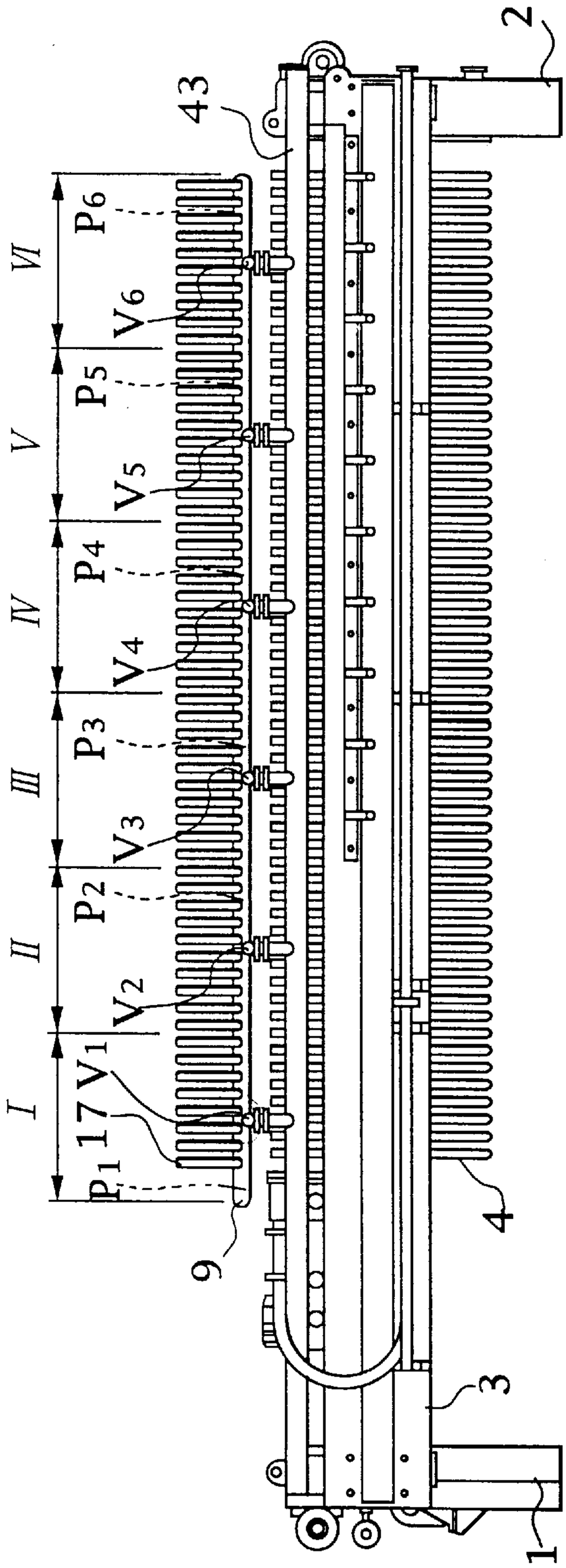

FIG. 12

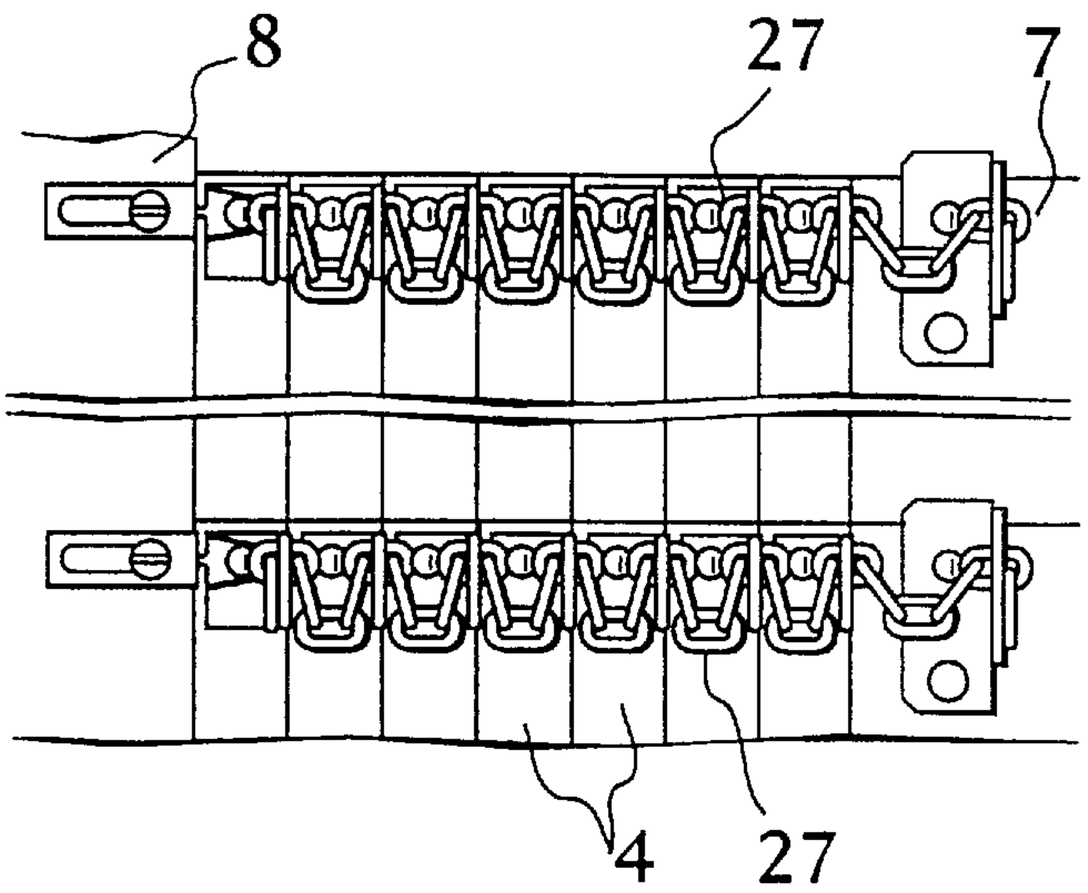

FIG.13A

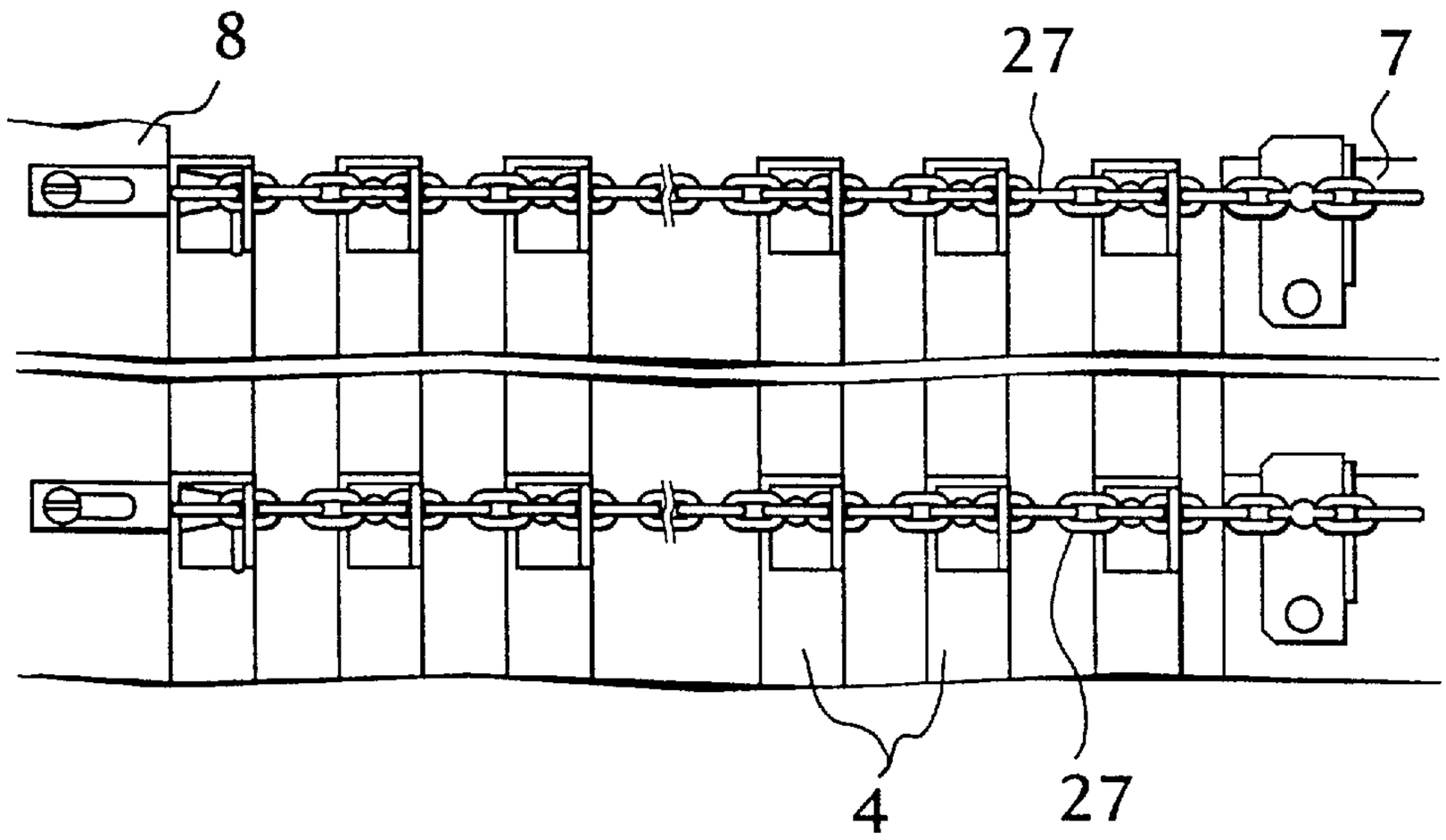

FIG.13B

APPARATUS FOR REGENERATING FILTER CLOTHES OF FILTER PRESS

BACKGROUND OF THE INVENTION

The present invention relates to an apparatus for regenerating clogged filter clothes of a filter press.

A filter press according to the present invention is used to separate solid components and liquid component in muddy water of earth and soil or slag from each other, and in particular to treat slurry which can relatively easily be filtered. Filter clothes are regenerated such that a plurality of filter plates (filtering chambers) disposed in parallel are simultaneously opened to simultaneously separate cakes and wash the filter clothes.

The filter press of the above-mentioned type having the structure such that the multiplicity of filter plates are simultaneously opened to wash and regenerate the filter clothes has been known as disclosed in Japanese Utility-Model Application Publication No. 5-9046 and Japanese Patent Application Laid-Open No. 8-24518. The filter press disclosed in Japanese Utility-Model Application Publication No. 5-9046 has a structure such that washing pipes disposed above opened filter plates are vertically rotated so as to be moved downwards to the positions among the filter plates when the washing operation is performed. As a means for separating cakes allowed to adhere to the filter clothes, a structure has been disclosed in Japanese Patent Application Publication No. 5-20124 having a structure such that cakes allowed to adhere to the filter clothes are vibrated so as to be separated from the filter clothes.

However, there has been no apparatus of a type which is capable of simultaneously performing separation of cakes formed among the multiplicity of the filter plates and washing of the filter clothes. A portion of slurry pieces can substantially be separated and dropped by simply opening the filter plates, while another portion of slurry pieces cannot be separated by vibrating the filter clothes and thus requires washing.

SUMMARY OF THE INVENTION

The present invention is found to solve the above-mentioned problems and an object of the present invention is to provide an apparatus for regenerating filter clothes which is capable of spontaneously regenerating filter clothes regardless of the characteristics of slurry.

In order to achieve the above-mentioned object, according to one aspect of the present invention, there is provided an apparatus for regenerating filter clothes of a filter press comprising: a plurality of filter plates movably disposed in parallel on a pair of horizontal guide rails; filter clothes each of which is put on filtering surfaces on the right and reverse sides of each of the filter plates; upper-portion support bars each having two ends projecting over two ends of each of the filter clothes to support the upper portion of each of the filter clothes; an opening and closing mechanism for connecting the filter plates to one another and simultaneously opening or closing a plurality of the filter plates; filtering chambers each of which is sectioned and formed between opposite filtering surfaces when the filter plates have been closed and which are opened when the filter plates have been opened; washing pipes each of which is disposed above a gap formed between the filter plates which have been opened and each of which extends along the filtering surface of the filter plate; nozzles provided for each of the washing pipes to spray washing water to each of the filter clothes; a main supply pipe for supplying washing water disposed in the direction of the filter plates and arranged to support ends of the washing pipes; a washing pipe support portion disposed substantially in parallel to the main supply pipe in the direction of the filter plates and arranged to detachably support other ends of the washing pipes; flexible pipes each of which connects the main supply pipe and each of the washing pipes to each other in a communicated state so as to supply washing water from the main supply pipe to each of the washing pipes; and vibration rod disposed below the two ends of the upper-portion support bar so as to be brought into contact with the two ends from a lower position and downwards separated from the same in order to vibrate the upper-portion support bars.

If the filter clothes of the filter press have been clogged, the apparatus for regenerating the filter clothes of the filter press having the structure such that all of the filtering chambers each of which is formed between filtering surfaces of the filter plates are simultaneously opened by opening the filter plates if the filter clothes are clogged so as to cause cakes formed in the filtering chambers to be dropped due to the dead weight. Thus, the cakes can easily be removed.

In a case where cakes, which have not been dropped due to the dead weight, are left on the filter clothes, the upper-portion support bar is vibrated by the vibration rod to vibrate the filter clothes. Thus, the cakes allowed to adhere to the filter clothes and thus left on the filter clothes can be separated and dropped.

If cakes, which could not been separated though they have been vibrated, are left, washing water are sprayed from washing pipes so that cakes clogged in the textures of the filter clothes are completely be removed.

As described above, the apparatus for regenerating filter clothes according to the present invention, having the structure such that the filter plates are opened and vibrated if cakes which cannot be separated are left, is able to easily regenerate the filter clothes. If cakes clogged in the textures of the filter clothes are left, the cakes are washed. As a result, the filter clothes can satisfactorily be regenerated. Therefore, the filter clothes can accurately and satisfactorily be regenerated to correspond to cakes having various characteristics.

When the filter clothes are regenerated, the present invention has the structure such that all of the filtering chambers are simultaneously opened to separate and drop and wash and remove cakes in all of the filtering chambers and on all the filter clothes. Therefore, the operations can significantly efficiently be performed. That is, the above-mentioned batch type filter press has the filtration efficiency which is calculated as the time in which no filtrate nor cake is discharged as a result of the operation of the apparatus. The regenerating apparatus according to the present invention has the structure such that separation of cakes and washing of the filter clothes are simultaneously performed in all of the filtering chambers. Therefore, the time, in which the solid-liquid separation is not performed, can significantly be shortened so that a significantly excellent filtration efficiency is obtained.

Moreover, the apparatus according to the present invention having the structure such that no obstruction exists near (above) the washing pipe enables assembling of the apparatus and the adjustment of the nozzles to be performed easily. Since each of the washing pipes can easily be detached, maintenance can easily be performed.

A structure may be employed in which the opening and closing mechanism have a hydraulic cylinder secured to the guide rails and including a hydraulic piston having a head portion which is moved forwards and rearwards along the

guide rails, a movable head attached to the head portion in such a manner that the movable head is able to move forwards and rearwards along the guide rails and connected to the outermost filter plate in the opening direction of the filter plates, and a link chain for connecting the filter plates to one another.

Since the above-mentioned structure has an arrangement such that the mechanism for opening and closing the filter plates is provided individually from the clamping mechanism, the size of the apparatus can be reduced as compared with a structure in which the movable stroke of a clamping cylinder of a clamping mechanism having a large scale hydraulic unit is set to be a large stroke to open and close the filter clothes. Moreover, the filter plate can quickly be opened and closed. Therefore, the regenerating operation can furthermore efficiently be performed.

A structure may be employed in which all of the filter plates are divided into two or more filter plate blocks each of which consists of a plurality of the filter plates, and the main supply pipe has a plurality of washing water passage pipes capable of independently and selectively supplying washing water to an required block.

As a result of employment of the above-mentioned structure, washing water can be supplied to each block. Thus, an operation of washing a block of the filter clothes can be performed, that is, the multiplicity of the filter plates are divided into several blocks so as to be sequentially washed. Thus, the size of the pump for supplying washing water can be reduced and the quantity of washing water can be saved.

Another structure may be employed in which two end portions of the vibration rod are individually operated.

As a result employment of the above-mentioned structure, the two ends of the vibration rod for vibrating the upper-portion support bar are individually operated. Thus, the bar for supporting the upper portions of the filter clothes can strongly be vibrated so that cakes allowed to adhere to the filter clothes can efficiently be separated and removed.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic side view showing a filter press having an apparatus for regenerating filter clothes according to the present invention;

FIG. **2** is a perspective view of FIG. **1**;

FIG. **3** is a partial side view of FIG. **1** showing the relative position between the washing pipes and the filter plates;

FIG. **4** is a front view showing an essential portion of FIG. **1**;

FIG. **5** is a front view of FIG. **1** showing a state where filter clothes are hung;

FIG. **6** is a side view of FIG. **1** showing a washing pipe;

FIG. **7** is a plan view showing a bracket for attaching the base of the washing pipe;

FIG. **8** is a plan view showing a bracket for attaching the base of the washing pipe;

FIG. **9** is an enlarged front view of portion IV of FIG. **4** showing a state where the leading end of the washing pipe is engaged;

FIG. **10** is a plan view showing the bracket for attaching the base of the washing pipe;

FIG. **11** is a front view showing the bracket for attaching the base of the washing pipe;

FIG. **12** is a side view showing a modification of a regenerating apparatus for a filter press shown in FIG. **1**;

FIG. **13**A is a side view showing a state of a link chain in a state where the filter plates are closed; and

FIG. **13**B is a side view showing a state of the link chain in a state where the filter plates are opened.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, the present invention will now be described.

FIG. **1** is a schematic side view showing a filter press according to the present invention, and FIG. **2** is a perspective view of FIG. **1**. FIG. **3** is a partial side view showing the positional relationship between a washing pipe and a filter plate, and FIG. **4** is a front view showing an essential portion shown in FIG. **1**.

As shown in FIGS. **1** and **2**, the main body of the filter press has a left frame **1** and a right frame **2** respectively located at the right and left positions; a pair of plate-like guide rails **3** horizontally extending between the near position of FIG. **2** to the far position of the same; and an intermediate frame **8** disposed at a substantially intermediate position between the two frames **1** and **2**. A multiplicity of filter plates **4** are, in parallel and movably, mounted on the guide rails **3**. Moreover, a movable head **7** is mounted on the right and left frames **1** and **2** at a position in a direction in which the filter plates **4** are opened in such a manner that the movable head **7** is able to move forwards and rearwards in the same direction as the filter plates **4**. The intermediate frame **8** is provided to correspond to a structure in which a multiplicity of the filter plates **4** are provided in parallel in order to improve the filtering performance. An opening/closing mechanism, a clamping mechanism, a washing mechanism and the vibrating mechanism, each of which will be described later, are disposed substantially symmetrically in the right and left directions (in the portions respectively adjacent to the left frame **1** and the right frame **2**) with respect to the intermediate frame **8**.

As shown in FIG. **1**, a hydraulic cylinder **5** including a hydraulic piston **6** for opening and closing the filter plates **4** is secured to the guide rails **3**. The hydraulic cylinder **5** includes the hydraulic piston **6** which has a head portion **6***a* capable of moving forwards and rearward along the guide rails **3**. The movable head **7** is attached to the head portion **6***a*, the movable head **7** being connected to an outermost filter plate **4***b* in the opening direction. The filter plates **4** are connected to one another by a link chain **27** (see FIGS. **3**, **13**A and **13**B). When the movable head **7** is moved forwards or rearwards by the hydraulic piston **6** of the hydraulic cylinder **5**, all of the filter plates **4** are simultaneously opened or closed through the link chain **27**. As a result, the intervals among the filter plates **4** in the opened state are controlled to be substantially the same by the link chain **27**. That is, the hydraulic cylinder **5**, the movable head **7** and the link chain **27** form the opening/closing mechanism according to this embodiment.

The clamping mechanism for applying a required pressure is connected to the movable head **7**. As shown in FIG. **2**, the clamping mechanism has a clamping cylinder **28** arranged to be operated by hydraulic pressure and a locking unit **29** for maintaining the clamping state. The above-mentioned clamping mechanism mutually clamps the filter plates **4** which are closed so that the adjacent filter plates **4** are brought to a sealed state. Thus, filtering chambers are formed.

The filtering chambers each of which is formed between the filter plates **4** will now be described.

As shown in FIG. **2**, a concave filtering surface **4***a* is formed on each of right and reverse sides of each of the filter plates **4**. A filter cloth **18** is put on the filtering surface **4***a*. As shown in FIG. **5**, bag portions **18***a* and **18***b* respectively are formed in the upper and lower ends of the filter cloth **18**. An upper-portion support bar **19** is inserted into the upper bag portion **18***a*, while a weight **20** is inserted into the lower bag portion **18***b*. The upper-portion support bar **19** has two ends **19***a* projecting over the two ends of the filter cloth **18**.

As shown in FIG. **4**, support columns **22** are stood erect over the two shoulder portion at the right and left positions of the filter plate **4**. A coil spring **30** is disposed around each of the support columns **22**. Each of two ends **19***a* of the upper-portion support bar **19** has a through hole **31** through which the support column **22** is inserted. In a state where the support column **22** is inserted into the through hole **31**, two ends **19***a* of the upper-portion support bar **19** are elastically supported by springs **30**. A nut **32** for preventing separation of the upper-portion support bar **19** is, by threads, received at the top end of the support column **22**. That is, the top end of the filter cloth **18** (see FIG. **5**) is elastically supported by the through hole **31** through the upper-portion support bar **19** and the support columns **22**. On the other hand, the lower end of the filter cloth **18** is hung to the lower portion of the filter plate **4** by the weight **20** (see FIG. **5**). When the filter plates **4** have been closed and thus the adjacent filter plates **4** have been joined up, a filtering chamber is formed between adjacent filter plates **4** (between opposite filtering surfaces **4***a*) in a state where the filtering surface **4***a* is covered with the pair of the filter clothes **18**.

As shown in FIG. **4**, an undiluted-solution supply portion **34** is formed in the upper portion of each of the filter plates **4**, the undiluted-solution supply portion **34** being allowed to communicate with the undiluted-solution supply passage **33** (see FIGS. **1** and **2**) in a state where the filter plates **4** are closed to supply slurry (the undiluted solution) intended to be filtered. As shown in FIG. **5**, a solution supply plate **21** for supplying the slurry from the undiluted-solution supply portion **34** to the filter cloth **18** is attached to the upper central portion of the filter cloth **18**. On the other hand, a solution discharge portion (not shown) allowed to communicate with the filtrate discharge passage **35** (see FIGS. **1** and **2**) in a state where the filter plates **4** are closed to discharge filtered solution is formed in the lower portion of each filter plate **4**.

A mechanism for washing the intermediate frame **8** will now be described.

As shown in FIG. **4**, a main supply pipe **9** for supplying water for washing the filter clothes **18** (see FIG. **5**) and a support pipe (a portion for supporting a washing pipe) **10** running parallel to the main supply pipe **9** are disposed above the right and left shoulders of the filter plates **4**, the main supply pipe **9** and the support pipe **10** being disposed in the direction of the filter plates **4**. Washing pipes **11** having a multiplicity of nozzles **11***a* are disposed between the main supply pipe **9** and the support pipe **10** to extend in the direction of the filtering surface **4***a* of each of the filter plates **4**. The base (an end) of the washing pipes **11** and a leading end (another end) of the same respectively have an engaging projection **11***b* and an engaging member **11***c* (see FIG. **6**). The engaging projection **11***b* is detachably supported by the main supply pipe **9**, while the engaging member **11***c* is detachably supported by the support pipe **10**.

The main supply pipe **9** and each of the washing pipes **11** are connected to each other in a communicated state by a tube (a flexible pipe) **17** made of a flexible tube. Thus, washing water is supplied from the main supply pipe **9** to each of the washing pipes **11** through the tube **17**. Note that a dripping pan **36** (see FIG. **1**) for receiving sprayed washing water is disposed below the filter plate **4**.

Each of the washing pipes **11** is disposed above the substantial center of a gap formed between opened filter plates **4**. The nozzles **11***a* are disposed to spray washing water to the surfaces of the filter clothes **18** respectively put on the filtering surfaces **4***a* on the right and reverse sides of each of the filter plate **4**. The two ends of the main supply pipe **9** and those of the support pipe **10** are supported by support bracket **1***a* provided for the right and left frames **1** and **2** and the brackets **8***a* provided for the intermediate frame **8** (see FIG. **3**).

The structure for attaching the washing pipes **11** will now be described with reference to FIGS. **4** and **6** to **11**.

As shown in FIG. **6**, the engaging projection **11***b* formed at the base of the washing pipe **11** is formed into a plate-like shape having a groove portion **37** cut from the leading end thereof. The depth of the groove portion **37** is determined to permit the washing pipe **11** to be moved from the normal attached position toward the base. To correspond to this, a bracket **12** having an angle cross sectional shape is attached to the main supply pipe **9** by a U-bolt **13**, as shown in FIG. **4**. As shown in FIGS. **7** and **8**, the bracket **12** has a pair of stoppers **12***a* stood erect from the bracket **12** and disposed apart from each other to permit the engaging projection **11***b* to be inserted. Each stopper **12***a* has an insertion hole **38**. By inserting the engaging projection **11***b* between the stoppers **12***a* and by inserting a pin **14** into the insertion hole **38** and the groove portion **38**, the base of the washing pipe **11** is secured.

As shown in FIG. **6**, the engaging member **11***c* disposed at the leading end of the washing pipe **11** is formed into an L-shape having an engaging hole portion **39**. To correspond to this, a support bracket **15** having an angle cross sectional shape is attached to the support pipe **10** by the U-bolt **13**, as shown in FIGS. **4** and **9**. As shown in FIGS. **10** and **11**, the support bracket **15** has an engaging member **15***a* having an L-shape cross section for forming a predetermined gap **40** from the support bracket **15** for permitting an engaging member to be inserted. The engaging member **15***a* and the support bracket **15** have holes **41** and **42** which form a through hole together with the engaging hole portion **39** (see FIG. **6**) of the engaging member **11***c* inserted into the gap **40**. When the engaging member **11***c* is inserted into the gap **40** and a pin **16** is inserted into the engaging hole portion **39** and the holes **41** and **42**, the leading end of the washing pipes **11** is secured.

Thus, the attached washing pipe **11** can easily be removed from a position above the filter plate **4** by removing the pin **16** inserted into the leading end of the washing pipes **11**, by moving the overall body of the washing pipes **11**, by removing the engaging member **15***c* at the leading end of the washing pipes **11** from the gap **40** and by upwards rotating the washing pipes **11** relative to the pin **14** in the base portion as indicated by an alternate long and two dashes line shown in FIG. **4**. Thus, maintenance, such as change of the filter cloth **18**, can easily be performed.

The mechanism for vibrating the upper-portion support bar **19** will now be described.

As shown in FIG. **4**, a vibration rod **23** is disposed on the lower surface of the two ends **19***a* of the upper-portion support bar **19** in such a manner that the vibration rod **23** faces the lower surface from a lower position. The vibration rod **23** is vibrated vertically by a lift mechanism **24** (see FIG.

2) to be brought into contact with the two ends of the upper-portion support bar **19** from a lower position and separated from the same downwards so as to vibrate the upper-portion support bar **19** and the filter clothes **18** supported by the upper-portion support bar **19**. The vibration rod **23** is structured such that the two ends of the vibration rod **23** are operated individually.

The apparatus according to the present invention has the above-mentioned structure to regenerate the filter clothes **18** clogged after a filtration operation has been performed such that the piston rod **6** is extended to open the filter plates **18**. When the filter plates **4** have been opened, each filtering chamber between the filter plates **4** are opened so that cakes, which can easily be separated, are separated due to the dead weight.

In a case where cakes which have not fallen due to the dead weight and thus the cakes are left on the filter clothes **18**, the vibration rod **23** is moved upwards so as to be brought into contact with the upper-portion support bar **19** in order to vibrate the filter clothes **18**. Thus, cakes allowed to adhere to the filter clothes **18** and left on the same can be separated and dropped.

Since the two ends of the upper-portion support bar **19** are operated individually, the upper-portion support bar **19** and the filter clothes **18** can vibrated strongly. Thus, cakes allowed to adhere to the filter clothes **18** can efficiently be separated and removed.

That is, cakes, which can easily be separated, can be removed by opening the filter plates **4** and by vibrating the filter clothes **18**.

Washing water is, from the nozzles **11***a* of the washing pipes **11**, sprayed to cakes left from separation even after vibrated and allowed to adhere to the filter clothes **18** because of clogging in the textures of the filter clothes **18** after separated and dropped cakes have been removed. Thus, even cakes clogged in the textures of the filter clothes **18** can be removed.

As described above, cakes, which can easily be separated, can be removed by opening the filter plate **4** and applying vibrations to the filter clothes **18** so that the filter clothes **18** are easily be regenerated. In a case where cakes clogged in the textures of the filter clothes **18** are left, washing is performed so that the filter clothes **18** are satisfactorily be regenerated. Therefore, the filter clothes can accurately and satisfactorily be regenerated to correspond to various conditions of the cakes.

When the filter clothes **18** are regenerated, the present invention has the structure such that all of the filtering chambers are simultaneously opened to separate and drop a cake in each filtering chamber and to wash the filter cloth **18** in each filtering chamber. Therefore, the operations can significantly efficiently be performed as compared with the conventional structure arranged to perform the process for each chamber or a group of several chambers. That is, the above-mentioned batch type filter press has the filtration efficiency which is calculated as the time in which no filtrate nor cake is discharged as a result of the operation of the apparatus. The regenerating apparatus according to the present invention has the structure such that separation of cakes and washing of the filter clothes are simultaneously performed in all of the filtering chambers. Therefore, the time, in which the solid-liquid separation is not performed, can significantly be shortened so that a significantly excellent filtration efficiency is obtained. Moreover, since the regenerating apparatus according to the present invention has both of the separation function and washing function, an adequate operation can be selected to correspond to cakes of various slurry pieces.

In the mechanical view point, the structure according to the present invention in which the washing pipes **11** is secured to a fixed position (the substantially central position of the gap) between the opened filter plates **4** enables the position of the washing pipes **11** with respect to the opened filter clothes **18** to be maintained. Therefore, the nozzles **11***a* can be pointed to the portions of the filter clothes **18** required to be washed more accurately as compared with the conventional structure in which the washing operation is performed while moving the washing pipes **11**. Since the filter clothes **18** are vibrated such that the vibration rod **23** is instantaneously brought into contact with the upper-portion support bar **19** of each of the filter clothes **18**, the vibration efficiency can significantly be improved.

Since the structure for supporting the washing pipes **11** is arranged as illustrated, the washing pipes **11** can easily be removed at a position above the filter plate **4**. Therefore, adjustment of the direction, in which the nozzles **11***a* sprays water, and maintenance of the nozzles **11***a*, such as change, can easily be performed.

Since the mechanism for opening and closing the filter plate **4** is provided individually from the clamping mechanism, the size of the apparatus can be reduced as compared with a structure in which the movable stroke of a clamping cylinder **28** of a clamping mechanism having a large scale hydraulic unit is set to be a large stroke to open and close the filter clothes. Moreover, the filter plate **4** can quickly be opened and closed. Therefore, the regenerating operation can furthermore efficiently be performed.

The filter plates **4** may be divided into six filter plate blocks (I to VI) each of which is composed of plural filter plates **4**, as shown in FIG. **12**. In this case, the inside portion of the main supply pipe **9** is divided into six washing water passage pipes P**1** to P**6** capable of independently supplying washing water to corresponding blocks (I to VI). Moreover, opening and closing valves V**1** to V**6** respectively are disposed between the washing water passage pipes P**1** to P**6** and a washing water supply passage **43** for supplying washing water to the washing water passage pipes P**1** to P**6**.

As a result of employment of the above-mentioned structure, the filter clothes **18** can be washed such that the opening and closing valves V**1** to V**6** may selectively be opened which correspond to the divided blocks I to VI required to be washed. Therefore, the size of the pump for pumping washing water can be reduced and thus the apparatus can be formed with a low cost. That is, a filter press according to the present invention is able to eliminate a necessity of washing the filter clothes for each batch. The filter clothes are required to be washed when the filter clothes have been clogged excessively. If the filter clothes are divided into 6 blocks arranged to sequentially be washed as shown in FIG. **12**, the discharge of the washing water pump can be reduced to one-sixth as compared with a structure in which the filter clothes are washed simultaneously. Moreover, the quantity of washing water can be saved.

What is claimed is:

1. A filter press comprising:

a pair of vertical frame members;

a pair of horizontal guide rails;

wherein one guide rail interconnects said frame members on one lateral side thereof and the other guide rail interconnects said frame members on the other lateral side thereof;

a plurality of filter cloths each having a pair of upper ends;

a plurality of filter plates each having opposed vertically oriented filtering surfaces, the plates movably disposed in parallel on the guide rails, each of the filter clothes covering the opposed filtering surfaces of a respective one of the filter plates;

a plurality of horizontal upper-portion support bars each having two ends, wherein each said support bars is disposed directly above and is parallel to the filtering surfaces of a respective one of the filter plates;

means for resiliently connecting each said support bar to an upper end of a respective said filter plate;

connecting means for connecting the upper ends of each said filter cloth to a respective one of said support bars so that the filter cloth covers the opposed filtering surfaces of a respective filter plate;

an opening and closing mechanism for connecting the filter plates to one another and simultaneously opening or closing a plurality of the filter plates;

wherein filtering chambers are formed between adjacent filtering surfaces of adjacent filter plates when the filter plates are closed and which are opened when the filter plates are opened;

a horizontal main supply pipe for supplying washing water connected to one lateral side of said frame members and extending parallel to said guide rails and located above the upper-portion support bars;

a support pipe connected to the other lateral side of said frame members and extending parallel to said guide rails and located above the upper-portion support bars;

washing pipes disposed above and extending parallel to the upper-portion support bars and extending between the supply pipe and the support pipe, each of the washing pipes disposed above a gap between the filter plates when opened;

first connecting members, each of which pivotably connects one end of each of the washing pipes with the main supply pipe;

second connecting members, each of which detachably connects the other end of the washing pipe with the support pipe;

flexible pipes, each of which connects the main supply pipe and a respective one of the washing pipes to each other in a communicated state so as to supply washing water from the main supply pipe to each of the washing pipes;

nozzles provided for each of the washing pipes to spray washing water to each of the filter cloths; and

a pair of vibration rods for vibrating the upper portion-support bars, one of the vibration rods being connected to one lateral side of the frame members for contact with one of the ends of the support bars and the other vibration rod being connected to the other lateral side of the frame members for contact with the other end of the support bars.

2. A filter press according to claim **1**, wherein

the opening and closing mechanism includes a hydraulic cylinder, a movable head, and a link chain, and

the hydraulic cylinder is secured to the guide rails and includes a hydraulic piston moved forwards and rearwards along the guide rails,

the movable head is attached to a head of the hydraulic piston and connected to one of the outer filter plates, and

the link chain connects the filter plates to one another.

3. A filter press according to claim **1**, wherein

all of the filter plates are grouped into plate groups, each of the plate groups including a plurality of filter plates, and

the main supply pipe has a plurality of washing water passage pipes capable of independently supplying washing water to each of the plate groups.

4. A filter press according to claim **1**, further comprising a lift mechanism engaged with each end of the vibration rods for vibrating the vibration rods individually.

5. A filter press according to claim **1**, wherein

each of the first connecting members includes a plate portion provided at one end of each of the washing pipes, a bracket provided for the main supply pipe, and a pin, and

the plate portion is disposed at a right angle to the guide rails and has a groove,

the bracket has a gap in which the plate portion is inserted, and

the pin is supported by the bracket within the gap and inserted in the groove as the plate portion is inserted in the gap.

6. A filter press according to claim **1**, wherein

each of the second connecting members includes a plate portion provided at the other end of each of the washing pipes, a bracket provided for the support pipe, and a pin, and

the plate portion is disposed in parallel to the washing pipes and has a first hole,

the bracket has a gap in which the plate portion is inserted and a second hole corresponding to the first hole as the plate portion is inserted in the gap, and

the pin is detachably inserted in the first and second holes as the plate portion is inserted in the gap.

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